

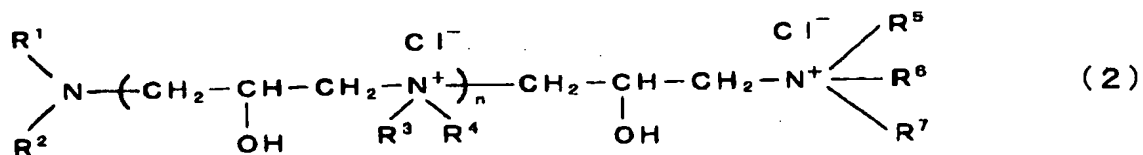
REMARKS

The abstract and specification have been amended in order to correct grammatical and idiomatic errors contained therein. No new matter has been added.

In order to expedite the prosecution of the present application, the subjects matter of Claims 1 and 3 have been combined and represented as newly added Claim 7. Claim 7 additionally recites that the copper electrolytic solution is used in the production of an electrolytic copper foil. Newly presented Claim 8 limits Claim 5 in specifying the surface roughness, ordinary temperature elongation, ordinary temperature tensile strength, high temperature elongation and high temperature tensile strength of the electrolytic copper foil of Claim 5. No new matter has been added.

Claims 1, 5 and 6 have been rejected under 35 USC 102(b) as being anticipated by Strauss et al. Claim 3 has been rejected under 35 USC 103(a) as being unpatentable over Strauss in view of Greaves et al. Claim 4 has been rejected under 35 USC 103(a) as being unpatentable over Strauss in view of Barbieri. Applicants respectfully traverse these grounds of rejection and urge reconsideration in light of the following comments.

The currently claimed invention is directed to a copper electrolytic solution for producing an electrolytic copper foil. The solution contains a quaternary amine salt obtained by a reaction between epichlorohydrin and an amine compound mixture composed of a secondary amine compound and a tertiary amine compound and an organic sulfur salt. The quaternary amine salt is represented by general formula (2)



where R^1 , R^2 , R^3 , R^4 , R^5 , R^6 and R^7 are each a methyl group or an ethyl group and n is a number from 1 to 1000. The present invention is also directed to an electrolytic copper foil produced from the inventive copper electrolytic solution and a copper-clad laminated board produced using the electrolytic copper foil.

As discussed in the present specification, conventional copper foils produced by an electrolytic copper foil producing apparatus have a mirror surface on the side touching the cathode drum but have a rough surface with bumps and pits on the opposite side thereof. With these bumps and pits, undercutting tends to occur during etching and the provision of fine patterns on the foil is very difficult. Given the density provided on printed wiring boards of today, a copper foil is needed that can be finely patterned as the circuit width decreases and this requires that the copper foil have a good etching rate and uniform solubility. Additionally, there is a need for the copper foil to have good elongation at ordinary and high temperatures for preventing cracking caused by thermal stresses as well as have a high tensile strength for good dimensional stability in a printed wiring board. Since the bumps and pits associated with conventional electrolytic copper foils make the copper foil unsuitable for fine patterning, smoothing of the rough side to a low profile has been used to eliminate this problem. However, this makes the process more expensive as it requires the addition of an additive such as glue or thiourea to the electrolytic solution, which sharply decreases the elongation at ordinary and high temperatures and lowers the performance of the copper foil when used for a printed wiring board. The present invention has been arrived at in order to overcome these problems.

The present invention provides a copper electrolytic solution which can be used to obtain a low-profile electrolytic copper foil having a low surface roughness on the rough side and has reduced transmission loss at a high

frequency, can be finely patterned and has excellent elongation and tensile strength at ordinary and high temperatures. It is respectfully submitted that the prior art cited by the Examiner does not disclose the presently claimed invention.

The Strauss et al reference discloses a process for producing bright metal electrodeposits in electroplating solutions containing additives which eliminate the adverse effects of impurities and the solutions upon the deposits produced therefrom. That is, this reference discloses a method of electroplating objects in electroplating baths containing brightening agents which makes it possible to produce bright electrodeposits despite the presence of interfering impurities in the electroplating bath. In Strauss et al, N-substituted monoamino compounds, free from carboxyl groups and selected from the group consisting of the compounds having the formula shown in Claim 1 of this reference are added to an acidic copper electroplating bath comprising hard water, technical grade copper salts and a sulfonic acid brightening agent. This reference discloses that the addition of the N-substituted monoamino compounds prevents the impurities from interfering with the brightening action of the brightening agent and prevents the electrodeposits from being adversely affected by the impurities. The N-substituted monoamino compounds may be employed in the form of their salts of inorganic and organic acids or in the form of the corresponding quaternary ammonium compounds. Column 4, lines 53-60 of this reference discloses a quaternary ammonium compound prepared by mixing together morpholine with epichlorohydrin and this quaternary ammonium compound contains a heterocyclic radical formed from nitrogen and morpholine.

In contrast to Strauss et al, the quaternary amine salt used in the present invention is a reaction product formed from a reaction with epichlorohydrin and an amine compound mixture made up of a secondary amine compound and a tertiary amine compound. Although Strauss et al does use a

N-substituted monoamino compound (tertiary amine compound), which may be in the form of a salt or quaternary ammonium compound formed with epichlorohydrin, it expressly excludes the use of the tertiary amine compound in combination with a secondary amine compound in the reaction with epichlorohydrin. Even in Example IV of Strauss et al which is relied on by the Examiner, morpholine is used alone and not in combination with another amine compound. As such, the quaternary amine salt of the presently claimed invention which is formed by the reaction of a mixture of a secondary amine compound and a tertiary amine compound with epichlorohydrin is expressly different from that shown in Strauss et al and the presently claimed copper electrolytic solution is clearly distinguishable from the electroplating bath shown in Strauss et al.

In order to further distinguish the claimed copper electrolytic solution from the prior art, the quaternary amine has been limited to that defined by the general formula (2) of originally presented Claim 3. As such, in the quaternary amine compound, R^1 through R^7 are each methyl or ethyl and expressly exclude a heterocyclic radical such as a morpholino group shown in Example 4 of the Strauss et al reference. Moreover, all of the tertiary amino compounds listed in columns 2 and 3 of Strauss et al are also excluded from the quaternary amine salts of formula (2) required by the present claims. Therefore, it is respectfully submitted that the currently claimed electrolytic solution is clearly patentably distinguishable over Strauss et al.

The Greaves et al reference discloses a method for inhibiting corrosion in an aqueous solution which comprises a step of adding to the system a corrosion inhibiting salt capable of forming a passivating film at the anode and a substantially linear cationic polymer. This reference has been cited by the Examiner as making it obvious to add an additive such as a quaternary ammonium polymer derived from epichlorohydrin and various amines such as secondary and

tertiary amines to the electrolytic solution of Strauss et al in order to inhibit corrosion in an aqueous system.

Applicants respectfully disagree.

The quaternary ammonium polymer having a formula in column 5 of Greaves et al is completely different from the quaternary amine salt of the present invention. That is, in the compound of the Greaves et al reference, three ethoxy groups are attached to the nitrogen on the left side and a hydrogen and methyl group are attached to nitrogen on the right side. Since the currently presented claims limit R^1 to R^7 to being either a methyl or ethyl group, the quaternary ammonium polymer of Greaves et al is expressly excluded from the presently claimed invention. Therefore, the Greaves et al reference does not cure the deficiencies of Strauss et al and the combination of these references do not even present a showing of prima facie obviousness under 35 USC 103(a).

The Barbieri et al reference discloses an electrolyte composition and process for electrodepositing bright, level and ductile copper deposits on a substrate. The electrolyte contains an additive system comprising a bath-soluble polyether compound, a bath-soluble organic divalent sulfur compound, a bath-soluble adduct of a tertiary alkyl amine with epichlorohydrin and a bath-soluble reaction product of polyethylene-imine and an alkylating agent. This reference has been cited by the Examiner as making it obvious to use an organic sulfur compound in the electrolytic solution of Strauss. However, the Barbieri et al reference does not cure the defects contained in the primary Strauss et al reference with respect to the presently claimed invention. Although the Barbieri et al reference discloses as component (c) a bath-soluble adduct of a tertiary alkyl amine with polyepichlorohydrin, this soluble adduct is different from that of the present invention. The quaternary amine salt of the present invention is prepared from epichlorohydrin and not polyepichlorohydrin which is required in Barbieri et al and the present invention requires an amine compound mixture made

up of a secondary amine compound and a tertiary amine compound and not just a tertiary alkyl amine which is required in Barbieri et al. The structural difference between the quaternary amine salt of the present invention and the adduct of Barbieri et al is clear from reviewing the formula (2) of the present claims with the formula of the adduct of Barbieri et al.

The Strauss et al and Barbieri et al references disclose an acid copper electroplating bath and Grieves et al discloses a method for inhibiting corrosion in an aqueous system. None of these references discuss a copper electrolytic solution for producing electrolytic copper foils and there is no suggestion or motivation to one of ordinary skill in the art to modify the quaternary amine compounds disclosed there to arrive at the presently claimed quaternary amine salt for modifying an electroplating bath or corrosion-inhibiting agent disclosed therein to an electrolytic solution disclosed in the references to the present invention directed to an electrolytic solution for the production of copper foils. As such, it is respectfully submitted that the presently claimed invention clearly is patentably distinguishable over the prior art cited by the Examiner.

Reconsideration of the present application and the passing of it to issue is respectfully solicited.

Respectfully submitted,


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